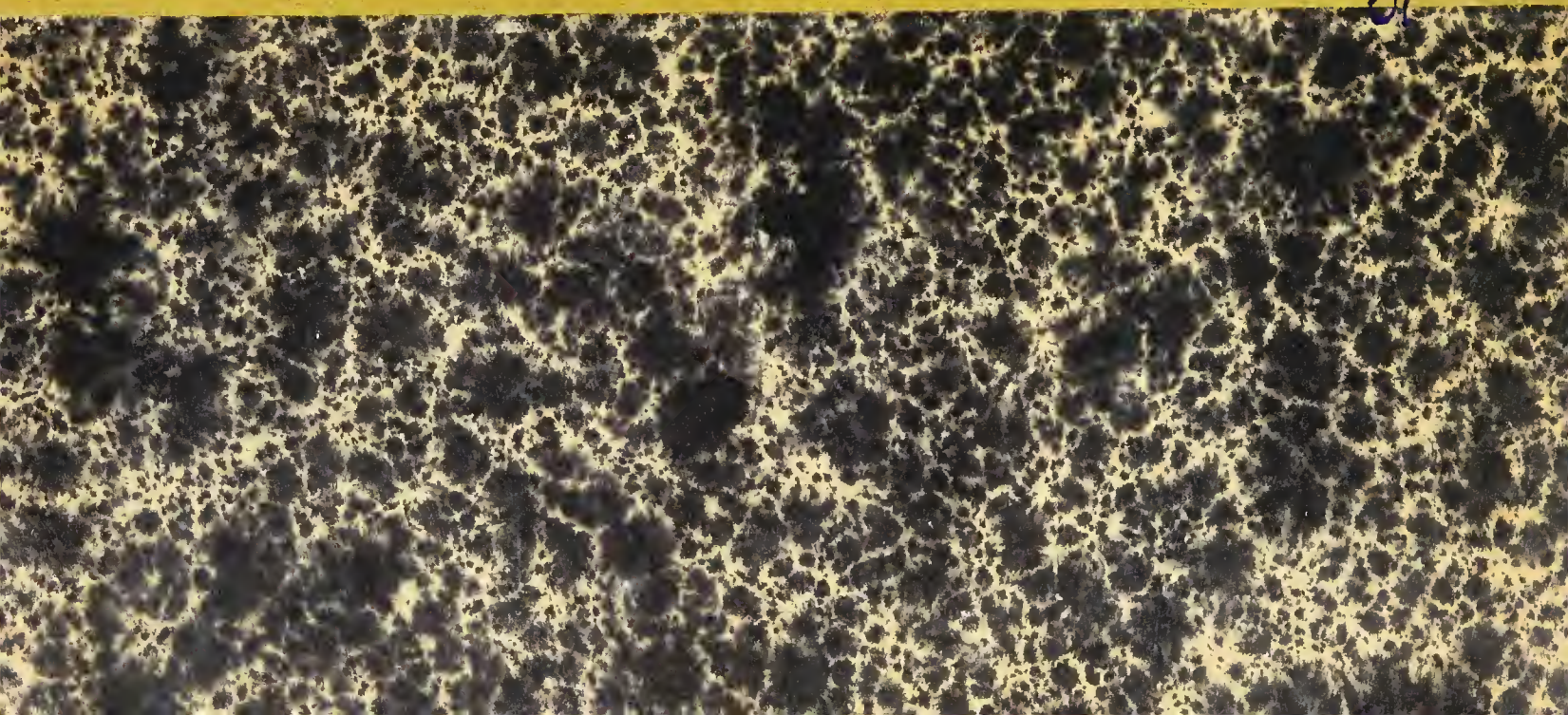

A CENTURY OF MEDICINE AT PADUA.

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By

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TO

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WILLIAM HARVEY

SERVED AS PHYSICIAN, 1609—1643.

A Century of Medicine at Padua.

I stood alone, musing, in the deserted quadrangle of the old University at Padua on a sunny spring morning in the year of our Lord, 1921. The day had just begun. Outside the college gates the *contadini* unladened their panniers and displayed their goods, and "the forum all alive with buyers and with sellers was humming like a hive." But within there was peace, and my thoughts lingered on the academic past of this ancient Mother and of her illustrious children who had gone forth from this place to the ends of the earth.

I.

It was in 1595 that Shakespeare put into the lips of Lucentio in *The Taming of the Shrew* the words :

> "Since for the great desire I had
> To see fair Padua, nursery of arts,
> I am arrived for fruitful Lombardy
> The pleasant garden of great Italy
> . . . . for I have Pisa left
> And am to Padua come, as he that leaves
> A shallow plash to plunge him in the deep
> And with satiety seeks to quench his thirst."

That was Padua's time of zenith as the first medical school of Italy, the country which was the birth-

place of the medical university of the West. In the eleventh century Salerno, in the twelfth Bologna, and in the thirteenth Padua, as our American cousins say, 'blazed the trail' and prepared for the grand sweep of the Renaissance. Before the close of the Middle Ages Italy possessed a score of examples of *universitas, schola,* or *studium generale.* The terms fluctuated as did the students, and sometimes a pope and sometimes an emperor was patron. The condition of their existence—for they can scarce be said to have been founded—was dependent at first upon a variety of factors, not the least being the migration of students, the presence of libraries or teachers, national politics, commercial activities, and the willingness or otherwise of communes to receive them and provide accommodation at a low cost. Thus it came about that the university at Padua was a daughter of Bologna, initiated by a secession of students from the elder institution in 1222. Six years later a secondary migration took place to Vercelli beyond Milan, leaving the studium at Padua bereft, but not extinct, and faced with the tyranny of Ezzelino.

The revival of Padua came in 1260, due to the commune granting additional privileges and to further immigration from Bologna. In the fourteenth century the city conceded full university rights, and the studium developed into two universities, that of the jurists and that of the humanists—the *universitas artistarum* (including medicine) being subordinate to the *universitas juristarum,* which was the larger, richer and more dominant. In each university the students were enrolled as "nations," each nation electing concilarii, who formed with the Rectors the

executive of the university. In the fifteenth century collegia, or hostels, were established and Padua rose to be one of the great universities of the learned world. To it flocked men from all parts of Europe.

There were two particular reasons why Padua flourished as the seat of a university. First, she made her way in the Lombard league and became the head of the towns of the Marches. As in Florence so in Padua, there were internecine struggles between guelf and ghibelline, though the terms did not bear the same or even a continuous meaning. Chroniclers in the thirteenth and fourteenth centuries were anti-imperial and yearned for a republican golden age. The House of Este (ancestors of our own royal dynasty), the families of Camposanpiero, of Romano, and of Carrara were destined at different times to rule in Padua, and their feuds and fortunes, and their conflicts with the people, spell out the long story of her struggle for independence. Victory placed her in a predominant position among her peers, and her favourable situation in the plains of Lombardy made her not only something of a health resort, to which her healing springs contributed, but a natural emporium for the wool and thread spinning industries. Thus in the thirteenth century she was ready to cultivate the arts of peace, and her Bishop being then in Bologna enticed two of its professors to join Albertus Magnus, the teacher of Thomas Aquinas, at Padua. So began the long line of distinguished teachers who made her fame.

The second reason for the ultimate emergence of the university at Padua was the protection of Venice. Between them there had been an inter-

mittent history of concord and strife. In the fourteenth century "great friendship" obtained, which ended in the absorption of Padua in the Venetian State, and her political history from the beginning of the fifteenth century onwards melts into the wider world of Venetian policy. Under the auspices of the Signory, learning at Padua began to sow seeds which in after years brought forth a rich harvest. Within her walls were gathered many of the great men of the time, and they fed her with seminal thought. The Signory patronised and encouraged them, paid part or all of their salaries, conferred honours and privileges on the Rector of Padua, and required students of Venice to study there. Indeed, as Dean Rashdall says, a period of study at Padua was "required as a qualification for the exercise of public functions at Venice. Padua became, in fact, the university town, or, as M. Renan styled it, the *quartier latin* of Venice; while the tolerance which under the protection of the great commercial Republic long defied the fury of the catholic reaction, attracted an exceptional number of students, especially medical students, from England and the Protestant countries." This substantial protection of Venice, lying as it did outside the Papal States, drew the most famous teachers of Medicine to Padua, provided exceptional facilities and equipment for the anatomical dissection of the human body, shielded non-Catholic students from papal importunity, and was some surety of personal safety, unavailable in the German universities and even in other centres of learning in Italy.

There was yet one other far-reaching advantage which Padua enjoyed from its allegiance to the Re-

public. For 400 years Venice was Byzantine in thought and deed, and Byzantium had, as Sir Clifford Allbutt has reminded us, conserved and embalmed and kept in safe custody that strange amalgam, Greek Medicine—a broad and living stream of medical knowledge and experience derived from many remote sources. Byzantine influences reached Padua through Ravenna and through Venice. The Tenth century tomb of St. Mark at Venice was built in Byzantine style, modelled on Santa Sophia, and a vast storehouse of Byzantine relic and treasure; venetian mosaics were wrought by Greeks; many madonnas and saints of Venice are Greek in aspect; its library is Greek in foundation; and before the early Renaissance Venice was "rather a Greek than an Italian city." Its argosies had sailed the seas, and during the fourth Crusade Doge Enrico Dandolo had won Constantinople, and thus the little Republic had vanquished the capital of the Eastern Empire. Though steady penetration of Greek inspiration had been going on for generations the world influence of Venice dates from that event. After that she stood at the gate of the East. She became the carrier of the nations. Her ships exported the fruits of Lombardy and brought back the timber of Dalmatia, the wares of Constantinople, the wines of the Ægean, the spices of Egypt, and the silks of Bagdad and the far Orient. And with this merchandise came back manuscripts and drugs.

Greece thus came to Venice 200 years before her university existed at Padua, and for four centuries the East had enriched her blood. Greek thought had, of course, influenced Italy from the days of

the Greek colonies in Magna Graecia, 700 years before Christ, but here at Venice though the harvest was late the aftermath was sure. The restoration of Greek letters was prosecuted by a series of envoys, fugitives, merchants and manuscript collectors. Cardinal Bessarion, a Greek, and the founder of the Library of St. Mark, Leontius Pilatus, Aurispa, who brought 238 manuscripts to Venice in 1423, Francesco Filelfo, who brought another similar cargo four years later, Andrea Dandolo, the Doge, chronicler and historian, Professor of Law at Padua—these and many others came before the Fall of Constantinople in 1453 and before the Medici Academy had been established at Florence, and they filled the libraries of northern Italy with treasures of learning from the East.

Two circumstances made their work more than fleeting. In the fourteenth century Petrarch, "the harbinger of day," as Gibbon calls him, and his friend Boccaccio, were there at hand, hungry to assimilate the Greek learning and fix it in Western culture. This they did. Their work was assisted and made durable by Aldus Manutus, who at the end of the next century set up his printing press at Venice and for the first time put into type some of the principal works of Greek literature. Thus it came about that at the end of the fifteenth century Padua, the University of Venice, found itself protected, equipped, ready and waiting for a golden age. The Republic and its merchants had secured for it independence of thought and study, the tide of history travelling on the great road from the Adriatic coast had left its mark upon it, and liberal thinkers from other nations began to bring their glory and honour into it.

II.

The unique advantages which Venice thus bestowed on Padua attracted our own fellow countrymen to its University. Thomas Linacre, the founder of the College of Physicians of London, and the friend of Grocyn, John Colet, Sir Thomas More and Erasmus, was one of the earliest of the English students to seek, at the end of the fifteenth century, a medical education at Padua. About 1485 he travelled to Italy with his former master, Selling of Canterbury, who had been appointed Ambassador by Henry VII. at Rome. He visited Bologna and lived at the Court of Lorenzo the Magnificent at Florence, sharing with his two sons, Piero and Giovanni, the tuition of Politian and Chalcondyles. A year later after visiting Rome he went to Padua, where he took the degree of Doctor of Medicine. On his return he translated Aristotle and Galen, practised physic, became physician to the King, and with his friends introduced the New Learning to England. He was the outstanding type of medical humanist. Forty years later Edward Wootton followed his example. He subsequently became physician to Henry VIII. and was the first of our English physicians to become an eminent naturalist and to include the study of zoology in the medical curriculum. Another of the early English students at Padua was John Caius, who worked under Montanus and Vesalius from 1539 to 1541, lodging in the house of the latter. He became illustrious both as anatomist and classical scholar. He was professor of Greek in the university co-operating with Realdus Colombus on the Greek text of

Aristotle. In 1543 he visited the libraries of Italy collecting manuscripts with the object of bringing to England the fullest knowledge obtainable of Galen, of Celsus, and of the learning of the Renaissance. He was one of the re-founders of Gonville and Caius College, Cambridge, physician to Queen Elizabeth, and President of the College of Physicians. He was the first to introduce the study of practical anatomy in this country and the earliest publicly to teach it. He also was a naturalist and likewise an epidemiologist, having been the first to describe the sweating sickness. Gesner told the Queen that Caius was "the most learned physician of his age."

Half a century passed before the arrival of William Harvey, the most famous English student who went to Padua. He was the son of Thomas Harvey, yeoman, of Folkestone, and was born in 1578. He studied at Caius College, Cambridge, and reached Padua probably in 1600, attending the lectures of Fabricius in anatomy, Minadous in medicine, and Casserius in surgery. He was a member of the more aristocratic *universitas juristarum,* which admitted a few selected medical students to its ranks. He was elected a *concilarius* of the English nation and his coat of arms, or *stemma,* was displayed in the court yard of the University where it was discovered in 1893—"Gulielmus Harveus Anglus." He probably graduated in 1602 and returned to England. His Lumleian lectures on the Circulation of the Blood were delivered before the College of Physicians in the spring of 1616, the year of the death of Shakespeare and Cervantes, and his immortal book,

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The sentence five lines from foot, page 14, should read: "He graduated in 1602 and probably returned to England."

"Exercitatio Anatomica de motu cordis et sanguinis in animalibus" was published at Frankfort in 1628. He was appointed physician to St. Bartholomew's Hospital and to Charles I., and died in 1657.

Many English and Scotch students followed these great examples and crossed the Alps to study at Padua in the days before Leyden made disciples of Englishmen. Their thirst for knowledge and their ambition to drink at Italian sources emboldened them to undergo the rigours of the enterprise. The journey itself, as we know from the colloquies of Erasmus, the journals of Luther and the diary of Evelyn, was sufficiently tedious and formidable. The sufferings of Erasmus during his continental travels are described by him to Linacre and Colet in his letters of 1500-1518, and nearly 150 years later Evelyn gives us an account of his return journey from Padua over the Simplon to London. In the time of Erasmus the mode of progress was by pack-horse, but Evelyn travelled also by coach. Whatever the mode the monasteries, inns and caravanserai furnished abundant discomfort, nor were the dangers of the way inconsiderable. Seebohm writes in the *Oxford Reformers*:

"One room serves for all comers, and in this one room, heated like a stove, some eighty or ninety guests have already stowed themselves—boots, baggage, dirt and all. Their wet clothes hang on the stove iron to dry, while they wait for their supper. There are footmen and horsemen, merchants, sailors, waggoners, husbandmen, children and women—sound and sick—combing their heads, wiping their brows, cleaning their boots, stinking of garlic, and making as great a confusion of tongues as there was at the building

of Babel! At length in the midst of the din and stifling closeness of this heated room, supper is spread—a coarse and ill-cooked meal,—which our scholar scarcely dares to touch, and yet is obliged to sit out to the end for courtesy's sake. And when past midnight Erasmus is shown to his bed-chamber, he finds it to be rightly named—there is nothing in it but a *bed;* and the last and hardest task of the day is now to find between its rough unwashed sheets some chance hours of repose. So, almost in his own words, did Erasmus fare on his way to Italy."

There were three or four routes from England to Padua, through France or Germany and over the Alps, or by sea to Genoa or Naples, or by sea to Venice and thence by road or canal. The usual route was that of the Simplon to Milan and thence by Bergamo, Brescia, and Verona. As the English student of the sixteenth century, taking this route, emerged from the hills and tramped or rode down the valley of the Bacchiglione he saw before him a brown walled city of the plains, embowered in a garden of fields and vineyards. On the north he would see, within the walls, the solitary square spire of the thirteenth century Church of the Eretami, immortalised by Mantegna and under the shadow of which Giotto painted his frescoes on the walls of the arena chapel; in the middle of the city rose the tower of the Palazzo del Podesta and to its right hand the domes and minarets of the glorious Franciscan Church of St. Antonio, the beloved friar, which had been the pride of Padua for 200 years, and which enshrines the work of Donatello; at the southern end, he could not overlook the thirteenth century fortress of Ezzelino on the wall, and the new campanile and glistening cupolas of St. Justina, the tomb of the saints; and for the

rest the stranger would look down upon the grey roofs and bell-towers of a medieval town. He would pass into the city from the open country through the Porta Giovanni, under the shadow of the Duomo, or possibly over the Roman bridge through the forbidding and imperious Porta Molino, and once inside he would find himself in dark, tortuous and narrow streets, arched and lined with arcades (the *portici*) and over-hanging storeys with small latticed windows.

The students' quarters lay to the east of the University, itself an old palace of the Maltraversi, situated in the heart of the city. Over the gateway was the Lion of St. Mark with the legend, *Gymnasium omnium Disciplinarum,* and above the escutcheon of the Doge of Venice the words, *Sic ingrede ut te ipso quotidie doctior evadas.* The student passed into a magnificent courtyard surrounded by a Doric colonnade and an upper loggia with Ionic columns—the loggia, the staircases, and the *aula magna,* the hall of the University, bearing on their walls the escutcheons, frescoed or sculptured, of former students. The University was nicknamed *Il bo,* perhaps because for a short period the palace had been used as the ox inn (*osteria del bo*), perhaps because the ox-tax of the city was paid into the University coffers. Round about the University, then as now, were situated the classrooms and technical laboratories, though in recent years the special medical and surgical departments have grown up in the vicinity of the hospital and Medical School in the Via del Fallopio, not far from the famous Physic Garden (and of which Fallopius was Keeper)

founded in 1545, when the medieval herbals had come into use. Between the new buildings and the University still run the old narrow streets and arcades, which in the sixteenth century were crowded with the students of all nations. There still remains the ancient grandeur, the stigmata of the fourteenth century, and the symbols of the art and literature and architecture of the Renaissance.

Arrived in Padua the wandering student of the sixteenth century was required to live under Spartan conditions. He was often poor, and like Luther, begged his bread. Food though cheap was inadequate and ill-assorted; the houses were dismal, the lattice windows were often filled with sheets of linen; the beds were rough and unkempt; artificial light was expensive and poor; and there was an almost entire absence of healthy recreation and amusement—periodical wild orgies of students, "too horrid and petulant mirth," being the natural reaction. The medical session began on St. Luke's Day in the autumn of each year and lasted until August. During the ten months the whole human body was twice dissected in public by the professor of anatomy. These were formal occasions and the attendance became so large that a sort of wooden barrack or tabernacle was built to serve as an anatomical theatre. In 1593, after Fabricius had been professor for thirty years, the Venetian authorities erected for him a small circular theatre which still exists, and here Harvey learned at his feet. The lectures on anatomy were delivered at nine o'clock in the morning, but others as early as six o'clock, and in the summer almost at day break. In the adjoining *aula magna* Galileo taught mathematics,

though many of his popular astronomical lectures were delivered in the open air. The courtyard and the loggia hummed with the sound of many voices as groups of eager students discussed the rapid march of knowledge or the acquisition of new truth.

III.

In its golden age Padua was a very wonderful place. Both place and age stood at the dawn. For there and then the sixteenth century left its indelible imprint on the youth of all nations and on the generations following. One of the oldest cities in Italy Patavia came under the Roman supremacy more than 200 years before Christ. In the fifth century it was destroyed by Attila the Hun, and the new city was taken by Agiluff the Lombard a hundred years later. From the Lombards it passed to the Franks, and during the guelf and ghibelline quarrels it alternately submitted to, or was conquered by, the tyrants and emperors or the Lombard league. In 1318 it took to itself as lord the head of the Carrara family, Jacopo, the patron of Petrarch, whose family ruled it, until, in 1405, it became a republic, passing within the dominion of Venice in 1509. Under the shadow of the wings of the Lion of St. Mark, faithful and beautiful daughter of Venice it remained—the fair possessor of priceless treasure in art and architecture. There it stands to-day a monument and embodiment of the Middle Ages, lying in the rich and fertile plains which for centuries proved its snare—the snare

which was predicted by Thucydides—between the Euganean Hills and the sea, with all the Alps lying to the north and to the south the long low stretch of the Marches away to Ravenna.

The glory which is Padua is, however, not in stone but in human endeavour: the birthplace of Livy and of Mantegna; the home of Petrarch; the land of the exile of Cosimo de Medici, patron of learning (accompanied by his friend Michelozzo, the Florentine sculptor) and of Palla Strozzi, the scholar and collector of Greek literature, and, last and greatest of the banished heroes, of Dante Alighieri; the workshop of Giotto and Donatello and Squarcione; the university of Dandolo, Vesalius, Frascatorius, Fabricius and Galileo; the medical school of Linacre, Wootton, Caius and Harvey; the haunt of Tasso and Ariosto and Boccaccio. What a galaxy! What immortal works of art, literature and healing spring from the deeds of these men. Is it surprising that there should come to drink at this source a long procession of thirsty students and seekers of all nations, over the Alps and over the sea? Is it astonishing that Padua proved to be the foster mother of some of the most dynamic of the new and living forces of Medicine, and which gave it renaissance when the light of morning broke over the West? And we may remember that, when daylight came, the Revival of Medicine passed in the direct line from Padua to Leyden, from Leyden under Boerhaave to Edinburgh, and from Edinburgh under Alexander Monro and William Cullen in the eighteenth century to the great medical schools of the New World—to Philadelphia, Columbia and Harvard.

IV.

(*a*)

Who were these prophets of Medicine at Padua and what did they do? The forerunner was a young Belgian of 22 years of age, seeing visions. His name was Andreas Vesalius and he was born at Brussels in 1515, his father being apothecary to Charles V., and his mother an Englishwoman, named Isabella Crabbe. He was educated at Louvain and Leyden, and naturally turning to medicine, studied anatomy under Sylvius in Paris. He served as a military surgeon in Flanders in 1536 and lectured in Italy in 1537. Subsequently in the same year he set his face to Venice to seek the patronage of its far-sighted rulers. In December he received the degree of Doctor of Medicine at their University of Padua and was entrusted with the teaching of Anatomy. No sooner was he installed as professor than he introduced, in 1538, the new method of dissection and demonstration. This was the beginning of an incomparable century of Medicine at Padua. Instead of merely reading Galen—whose books had fixed medical knowlege for 1,400 years—Vesalius began to study the human body, to be guided by what he found and what he could see rather than by Galen. Nature, and not books, observation, and not authority, was the new method. The young men of Padua answered to the new voice and the new way, they saw instinctively that it was right, and an epoch began. The undisputed sway of the written word ended, and Vesalius declared in uncompromising fashion what he saw with his own

eyes and handled with his own hands. "I had to put my own hand to the business," said he. Five years he thus spent in untiring labour, always with the vision yet not weaving webs of fancy, tracking out the structure of the human body as it actually is, dissecting it, demonstrating it to the crowds of students who hung on his words, and finally recording it in the folio pages of his *Fabrica Humani Corporis,* published at Basel in 1543, a lucid and orderly survey of acquired facts. "This book," said Sir Michael Foster, "is the beginning not only of modern anatomy but of modern physiology. . . Upon the publication of the *Fabrica* the pall of authority was once and for ever removed." It ended, for all time, the long reign of fourteen centuries of precedent; it began in a true sense the renaissance of Medicine. It added immensely to the knowledge of the body, it introduced a true method of science, above all, it engendered a new spirit.

Others had dissected before him in Alexandria, at Salerno, and elsewhere. Mundinus in 1315, and Carpi in 1521, had advanced the study of Anatomy at Bologna and proved themselves the forerunners of Vesalius—the anatomical painters of the fifteenth century, Verrochio, da Vinci, Dürer and Signorelli had used surface anatomy in the fine arts—but he it was who established and tilled the ground they had gained, and who opened the new book of Nature. "Vesalius was the first to collect on a large scale," says Dr. Klebs, "the accumulated mass of anatomical facts he had obtained from his predecessors, notably Galen. By his own observations he was able to correct some of them and to add new ones. The descriptive, systematic and especially graphic

ANDREAS VESALIUS.

presentation of his great anatomic knowledge in a most impressive outward form was bound to exert a reformatory influence. This is without doubt his own intellectual deed." His brilliant and vigorous advocacy brought down upon him envy and opposition, and in 1544 he left Padua to become court physician to Charles V. and subsequently to Philip. He died at Zante on his way back from a pilgrimage to the Holy Land in 1564—the year of the death of that other great anatomist, the painter Michaelangelo. He was succeeded in the professorship by Realdous Colombus, one of his pupils, who, following Michael Servetus the Martyr, correctly described the pulmonary circulation. In 1551 Colombus was succeeded by Gabriel Fallopius, who studied the anatomy of the pelvis, and who in his turn was followed by Fabricius, Casserius and Spigelius—all in the apostolic succession, all keeping alive the Vesalian fire, all laying anew the foundations of anatomy and physiology. In England this was done by John Caius, friend and pupil of Vesalius at Padua.

(*b*)

Three years after the issue of the *Fabrica* at Basel there appeared from the printing press at Venice a remarkable book, *De Contagione* by Hieronymous Fracastorius, poet and physician, of Verona. He was born in that city in 1483 and was sent to Padua for his medical education. After the Venetian War of 1509 he settled as a medical practitioner at Verona and cultivated the love of science,

literature and philosophy he had acquired at Padua. He lived the greater part of the year on the Caphian Hills overlooking Lago di Garda, and here, at the age of 47, he brooded over the severity of the times and the cruelty and injustice of which he had been the witness in his native city, the aftermath of the wars between Francis I. and Charles V., and between the imperial and republican factions of Verona. He has left us a stanza of his sombre thoughts :

> To what estate, O wretched Italy,
> Has civil strife reduc'd and moulder'd thee!
> Where now are all thy ancient glories hurl'd?
> Where is thy boasted Empire of the world?
> What nook in thee from barbarous Rage is freed
> And has not seen thy captive children bleed?

But Fracastorius had a more constructive message to leave behind than this sad note. For here in his country villa he wrote the two medical books which brought him fame. The first was a poem, *Morbus Gallicus,* printed at Verona in 1530, the second was *De Contagione* in 1546. In his medical practice Fracastorius had seen many cases of syphilis, plague, epidemic typhus and consumption, and his book is a record of his views as to the contagion of these diseases by seeds or *semina,* which could, he believed, be generated spontaneously. He described three separate modes of infection, (a) by personal contact, (b) by intermediate agents, fomites, and (c) by aerial convection. He likens the first form to putrefaction passing from one grape or pear to another (as he had observed it in his garden), the *seminaria contagionum* being carried from one to another. The second mode is, he says, the same

in principle though the seeds, or virus, may remain intact and active for long periods. Infection conveyed by air is more subtle and penetrating, and takes many different forms, some attacking animals and others man; some the old and others the young, some one organ of the body as the eye, others deeper organs, like the lungs. Fracastorius compared the process of contagion with fermentation of wine, two centuries before Pasteur, and he differentiated poisons from infections, showing that the former are not able to multiply or reproduce in the individual an agent capable of attacking another person. He introduced the term "syphilis," and was one of the earliest to describe the disease; he also described typhus fever and differentiated it from plague and other current pestilences; and he argued that consumption was a contagious disease contracted by habitual residence with a consumptive, and that the infection may remain attached to clothing or house.

Mercurialis said that Fracastorius first opened men's eyes to the nature of contagion, and Dr. Charles Singer considers that he was the first writer to place "the theory of infectious diseases on a firm and rational foundation." His doctrine of spontaneous generation was disproved by Redi, and some of his views were dispelled by the invention of the microscope. His works were widely read and constituted the culmination of the medical conceptions of the Renaissance in regard to infection. He gathered up the evidence of three centuries and stimulated future study in these matters by Fallopius at Padua, and the great Jerome Cardan of Pavia. His conceptions were studied critically

in England by Sydenham, put into operation by Richard Mead and Sir John Pringle in the eighteenth century, and scientifically proved during the nineteenth by Pasteur, Koch and their disciples. Fracastorius died 'mid Caphian Hills' in 1553, and monuments were erected to his memory at Padua. "The age in which he lived," wrote his biographer, "saw nothing equal to his learning but his honesty."

(*c*)

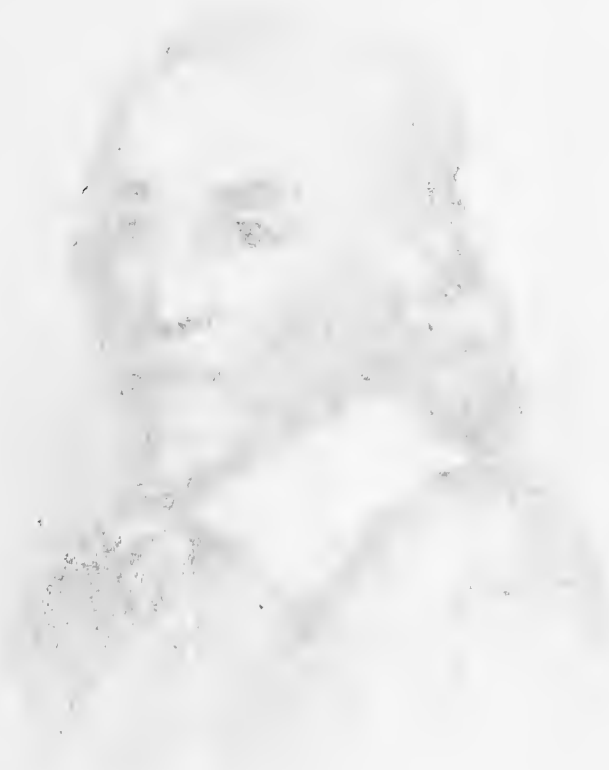
There is a small Tuscan town in the valley of the Paglio, near Orvieto, named Acquapendente, and there in 1537 was born in humble circumstances Hieronymous Fabricius. Though his parents were poor they contrived to send their boy to Padua to study medicine under Fallopius. His progress was so rapid that in eight or nine years he was called to the famous chair of Vesalius, but though the latter was professor for only five years Fabricius of Acquapendente reigned for upwards of forty, receiving from the Venetian republic the supreme honour of the gold chain of the Order of St. Mark. It was for him they built the new Anatomy theatre to celebrate thirty years' service, and in that theatre he taught Harvey.

Fabricius was a distinguished surgeon and scholar as well as anatomist. Above all he was a naturalist and taught the comparative structure of all animals. He wrote a book, *De formatione ovi,* in which he described the development of the chick in the egg, and in his *De Respiratione,* on which he was working when Harvey came to Padua, he

sets out his knowledge of the mechanism of breathing and of locomotion. On the subject of the circulation he was a Galenist, though he added new knowledge as to the form, position and distribution of the valves of the veins, which he described as "little doors." His book on *Venarum ostiolis* was published in 1574. He believed that these valves delayed the flow of blood—which Galen-like he assumed was "crude" blood travelling from the heart to the tissues—so that the limbs should not become congested with too great a flow of blood. Fabricius, who also wrote on the eye and ear, the structure and functions of the skin, the larynx and speech, was an enthusiastic teacher and investigator, with generous sympathies and a keen sense of the responsibilities of his position, an all-round workman —anatomist, physiologist, surgeon, embryologist, historian. He exerted immense influence on generations of students and vastly extended the reputation of Padua.

It was from this man that Harvey learned comparative anatomy, physiology and embryology, and from him too he also learned to be a medical humanist. But the venerable old man was a Galenist and the dead hand of the Pergamite lay heavy upon him. "So strong was the hold upon his mind of conceptions coming down from the past," said Sir Michael Foster, "that Fabricius's eyes were blinded to the facts staring him in the face, and his ears were deaf to voices crying out new views." He was 62 when Harvey went to sit at his feet; he was followed in the chair by his faithful servant Casserius, and in 1616 by Spigelius, who both carried on his work. But the succession passed to Harvey.

What exactly was the discovery which Harvey made? Let us consider it in the briefest possible form. Galen and Vesalius had both taught that the blood current acquired nutritive properties in the liver, that some of it when in the heart passed through the wall from the right to the left ventricle, and that air became mixed with the blood in the left ventricle. In 1553 Michael Servetus declared that no blood passed through the interventricular septum and that the blood was aerated by its passage through the lung. Twenty years later Cisalpinus of Pisa had grasped the principle that the heart received blood from the veins and propelled it through the arterial system. Lastly, Fabricius of Padua had described the structure and position of the valves of the veins, though he had not understood their purpose. Thus matters stood when Harvey came to Padua. He listened to Fabricius, he then studied the matter for himself in man and animals, he considered the structure of the circulatory system and its purpose, and he "weighed" (to use his own term) the physical factors affecting it. And briefly this is what he found. He first showed the nature and purpose of the heart beat, that the heart undergoes a contraction and a constriction, and forces all its contained blood into the arteries, the right ventricle into the pulmonary artery to the lungs and the left into the great artery (aorta) to the body, and no blood passes through the intervening wall. Secondly, he found that the blood coursing through the body was passing *from* the heart in the arteries and 'climbing back' *to* the heart in the veins by the support of their valves, "a motion, as it were, in a circle." "The



WILLIAM HARVEY.

blood in the animal body," he wrote, "is impelled in a circle, and is in a state of ceaseless motion; that this is the act or function which the heart performs by means of its pulse; and that it is the sole and only end of the motion and contraction of the heart." Thirdly, he saw that though the blood undergoes changes in the lung—the lesser circulation, and in the body tissues—the great circulation, it is one and the same blood. "Sense and reason alike assure us that the blood contained in the left ventricle is not of a different nature from that in the right. . . . It is the same blood in the arteries that is found in the veins." That is Harvey's three-fold discovery.

Its effect was amazing. For his mode of procedure vindicated for ever the experimental method; his finding placed the blood in the forefront of physical life, and gave it an altogether new meaning, chemical and physiological; lastly, the demonstration of the circulation gave a true conception to nutrition. Here was an end to "spirits" and "vapours," here was the operation of physical and physiological law. There was but one link missing, how the blood passed from the arteries to the veins. It was not until four years after Harvey's death that, with the aid of the microscope, Malpighi in 1661 observed the capillaries uniting by their network arteries and veins.

(*d*)

A fourth type of the Paduan pioneers who created its golden age of Medicine is Galileo Galilei. He was the son of a Florentine noble and was born at

Pisa in 1564, the year in which Vesalius died and Shakespeare was born. He inherited from his father an aristocratic name, a love of music, art and mathematics, an enquiring mind, and an impoverished patrimony. His father intended him for commerce, but the boy showed so much scholarly capacity at the convent school that at the age of 17 he was sent to the University of his native city to study medicine. Nevertheless, he preferred Euclid and Archimedes to Hippocrates and Galen, and turning to mathematics became at the early age of 26 professor of that subject in the University.

Two episodes of his life at Pisa have come down to us. One day in the Duomo his attention was attracted by the great bronze lamp of the Cathedral, which after lighting the verger had left swinging to and fro on its chain. Galileo timed its oscillations by the only watch he possessed, namely, the beat of his own pulse—the rhythm of which he also measured by the pendulum—and observed that the time occupied by the swings was the same though the range became smaller. Thus was suggested the law of the isochronism of the pendulum, which led to the invention of the astronomical clock. On another occasion he climbed the leaning campanile adjoining the baptistery, and before the assembled University he dropped a 100-pound shot and a one pound shot from the top of the tower. Together they fell, together they struck the ground. "The simultaneous clang of those two weights," says Sir Oliver Lodge, "sounded the death knell of the old system of philosophy and heralded the birth of the new." This contraversion of the Aristotelians concerning the law of falling bodies contributed, with

other like innovations, to Galileo's unpopularity at Pisa, and in 1592 he accepted the offer of the Senatori of Venice to be Professor of Mathematics at Padua.

Now began the splendid period of Galileo's life. He was 28, and, like Vesalius and the young Fabricius, he came into his kingdom in the first flush of manhood. His fame drew crowds of students, to whom he lectured in the *aula magna,* where his "pulpit" or rostrum may still be seen, or, if the accommodation proved inadequate they all turned out into the open air. He taught them the laws of motion and mechanics, the principles of the sun dial, and "the mutability of the celestial globe." He perfected before them the telescope and invented a proportional compass, and with these instruments he demonstrated to the astonished students the Copernican helio-centric theory of the heavens, the new star of 1604, the mountains of the moon, the Milky Way, sun spots, and the satelites of Jupiter. The Senate, as well as the students, fell under his spell. The six year tenure of the professorship ran a second lap, and then the twelve years became eighteen. It was a brilliant career, perhaps even in that great time the most dazzling in Europe; it marked advance in the understanding of the laws of physics and the fundamental properties of matter. For at Padua Galileo did much else than teach mathematics. He enlarged the field of the mind of man, he taught the balance between induction and deduction as a scientific method, he advanced the far-reaching truth that all physical forces within the human body and outside it are *measurable*. But alas! the fate of the prophet over-

took him and in 1610 he left Padua never to return. Two years later he published his belief in the Copernican theory and came under the papal ban; in 1632 he underwent the persecution of the Inquisition; and ten years after the blind, bereaved, old man passed beyond the power of his traducers. In spite of his recantation of his scientific faith, his work remained and brought forth a hundred-fold. For it was sown in strength and raised in power. "This is Galileo's main glory," says Sir Oliver Lodge, "that he first laid the foundation of mechanics on a firm and secure basis of experiment, reasoning and observation. He first discovered the true Laws of Motion."

The forerunners of Galileo had been Copernicus and Paracelsus, Telesio, Patrizzi and Campanella; his contemporaries were Kepler and our own William Gilbert, of Colchester, the author of *De Magnete,* and the first President of the College of Physicians who was pre-eminent as physicist; and his immediate successors were Sanctorius of Padua, Descartes, Stensen, Borelli and Malpighi. Yet once more the succession passed to an Englishman, Sir Isaac Newton. He it was who became Professor of Mathematics at Cambridge when 26 years old, and who took the learning of Descartes and Galileo, reformulated it and applied it to the differential calculus, to the law of gravitation and a complete theory of astronomy, and to the beginnings of spectrum analysis. The *Principia* was published in 1687.

It is important in the history of physiology to remember that for eighteen years the influence of Galileo permeated the first medical school of the

age and left its ineffaceable mark upon the growing science of all living things. Harvey himself must often have listened to the Professor of Mathematics, for the aula magna and the anatomical theatre adjoined each other, and Galileo's amazing lectures, were the talk of the University. We know to what physiological purposes Harvey applied the principles of mechanics. But even before this, and only a year after Galileo had left the University, Sanctorius, the professor of medicine at Padua, introduced physical measurement for the determination of chemical and physiological change. He constructed a chair suspended to a steel-yard, and by this balance weighed himself before and after regulated meals, and thus measured the loss of weight due to, what he termed, insensible transpiration. "If the food and drink in one day amount to eight pounds," he says, "the insensible transpiration will generally amount to about five pounds." Quaint and imperfect as were his methods he was a pioneer of the physical measurement of physiological processes.

Descartes, the philosopher and mathematician, though not associated with Padua, was a follower of Galileo, and added the method of reasoning to that of observation and experiment. It was part of his creed that man was a machine, an automaton (*machine de terre*) inhabited and governed by a rational soul (*âme raisonable*), and he was the first to explain physiological and mental functions in a mechanical manner. "Other authors," said Stensen, "describe man; Descartes puts before us merely a machine." From the medical standpoint two of the greatest disciples of Galileo were Borelli

of Pisa and Malpighi of Bologna. Borelli was born at Naples and was two years old when Galileo left Padua, but in 1656 he followed him in the chair of mathematics at Pisa. He devoted himself to the mechanics of physiology, muscular movement, heart beat, and the resistance and elasticity of the arteries. He also investigated the mechanics of respiration, secretion and excretion. Borelli's friend Malpighi became professor of medicine at Bologna, Padua's great neighbour, and there with the aid of the newly invented microscope he worked as naturalist, embryologist and pathologist. He discovered the capillaries and thus threw new light on the nutrition of the tissues, and as histologist he demonstrated the relation of structure to function and the response of structure to physical forces.

These men were the descendants of Galileo, and laid the foundations on which we build in that new world of physics, mathematics and chemistry in their relation to Medicine which marks our own day and generation. But as I have said the succession passed to England,—and to the genius who knew, yet knew how little he knew. When an old man, full of honour and at the height of his fame, Sir Isaac Newton wrote these words : "I know not what the world will think of my labours, but to myself it seems that I have been but as a child playing on the sea shore; now finding some pebble rather more polished, and now some shell rather more agreeably variegated than another, while the immense ocean of truth extended itself unexplored before me."

V.

Such were four of the leaders and teachers of the School of Padua in the century which began on New Year's Day, 1538—an anatomist, a practitioner, a professor, and a physicist. Their influence spread through Europe, and Padua, in spite of conservative and reactionary elements, gave many sons to the advancement of learning and the science and art of Medicine. Its contribution was supreme in three respects.

First and foremost, Padua called men's minds back to Nature. Not Galen or other authority, not the text of a book, not consistency with tradition, but the study of the Human Body was the issue that was joined—in the splendid words of Vesalius "the study of that true bible, as we account it, of the human body and of the nature of man." This was the source of new truth in 1538, and it is the source to-day. "It was in Padua," wrote Sir Clifford Allbutt, "that Medicine, long degraded or disguised, was to prove her lineage as the mother of natural science and the truth of the saying of Hippocrates that to know the nature of man one must know the nature of all things." This return to Nature was not merely an elegant fancy or philosophic idea, it was a way of thought and of life. Nature was to be observed, rather than interpreted, as the *fons et origo* of truth; but more than that, she was to be interrogated, cross-examined, tested. The Paduan School made experiments and control experiments, as Aristotle had done before them; but they did more, for following in the footsteps of Roger Bacon, they applied the experimental *method*

to all things. It has been wisely said that "by the ordering of experiment after a definite plan discovery is to be guided, doctrine tested, error disipated, and the succession of natural phenomena ascertained." This was what Galileo and Harvey did. By design they verified the fundamental premises. They taught the world mighty truths, but better than that, the truths were natural and the offspring of their own experience. Their teaching was founded, as all consummate teaching must be, on their own research, their own first-hand knowledge of truth at the source. It is the supreme order, be the endeavour what it may.

Then in the second place, though to construct a true method is a larger gift to mankind than to discover items of knowledge, the Paduan School rendered inestimable service in extending the boundaries of learning. Vesalius revealed morphology as the bed-rock of systematic medicine; Fracastorius was the first of the moderns in the realm of infection and epidemiology; Fabricius was one of the greatest of the early exponents of the elements of physiology and embryology; and Galileo opened the august chapter of the laws of mechanics and physics. In the main, therefore, Padua is associated with the basic elements of physics, anatomy and physiology —in a word, with the essentials of the mechanics, structure and function of the body. The superstructure was to be built by other men. What is significant, though not surprising, is that these Paduan pioneers inspired, as we have seen, a long succession of descendants and disciples whose intellectual germ plasm has continued to reproduce its kind in many nations down to our own day.

Their work was of the nature of fruit; it grew from seed and it had within it the seed of more fruit. That is their enduring fame. We may be proud, and should be profoundly encouraged, that chief of them all was an Englishman, the immortal William Harvey, whose demonstration of the circulation of the blood and whose method of proof opened a new chapter not for Medicine only but for mankind. "I profess both to learn and to teach anatomy," he wrote, "not from books but from dissections; not from the position of the philosophers but from the fabric of nature. I avow myself the partisan of truth alone."

Lastly, there is a third characteristic of the progress of Medicine at Padua in its wonderful century, and it is this, there was co-operation and integration of the one into the many and the many into the one. The forerunners handed the glowing torch to these men of Padua—Vesalius, Fracastor, Galileo and Harvey—who carried it forward with enthusiasm, devotion and courage, and handed it on aflame to their followers—that was co-operation. But they did more. Biology was made by them to subserve anatomy, the anatomy was laid as the foundation of physiology, the physiology was illuminated and explained by physics, and the whole was applied to the healing art—that was integration. There was correlation and interdependence and integration; there was a fresh and large understanding of the unity of nature. These men lit a candle in Europe, the lamp of truth, and they used it to push out further into the darkness which surrounded them, seeking the many in the one. They kept their lamp well trimmed and burning, but always,

though sometimes unconsciously, for the single-minded Search. Coming out of a great time they sang again the song of man's inheritance, of his unconquerable mind, of his partnership with the eternal wisdom. And in seeing this vision and singing this song, they made their day the Dawn.

Was Browning thinking of such men in the last words of *Paracelsus*, in the hospital of St. Sebastian in 1541?

> "If I stoop
> Into a dark tremendous sea of cloud,
> It is but for a time; I press God's lamp
> Close to my breast—its splendour, soon or late,
> Will pierce the gloom: I shall emerge one day."

. . . . . .

Some of these were my musings that spring morning in Padua. But the evening came, and its long shadows fell across the plains of Lombardy and enshrouded the Euganean Hills; the workers came in from the fields and vineyards, the city toilers rested from their labours, the great bell of the Cathedral sounded the Ave Maria at sunset; and walking away in the twilight through those quiet and forsaken streets of the Middle Ages, familiar three centuries ago to Fabricius and Galileo and Harvey, I listened to "the deep sad murmur of voices long dead."

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